Linking digitalization and human capital to shape supply chain integration in omni-channel retailing

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Abstract

Purpose: Supply chain integration (SCI) is key to implementing omni-channel retailing (OCR) strategy. In this paper, we explore the role of digitalization as a driver of SCI, as well the role of human capital (HC) in digitalization, using a knowledge management (KM) perspective.

Methodology/Approach: An empirical study was conducted using survey research. A sample of 188 omni-channel retailers in the Chinese market was analyzed using factor analysis and structured equation modeling (SEM) to examine the hypotheses presented in the conceptual model.

Findings: This study reveals that HC is positively related to the level of a firm's digitalization in OCR, and that digitalization is positively related to the retailer's SCI. Moreover, we found that employees' capital has a greater impact on digitalization than managers' capital, while digitalization has a stronger driving effect on internal and customer integration.

Research Limitations/Implications: The findings suggest that although digitalization requires retailers to accept the long-term investment challenges, it has a significant positive effect on the key of OCR strategy implementation, i.e. SCI. The findings also provide evidence for the application of KM in OCR, as this theoretical lens enriches our understanding of the phenomena of SCI in OCR and provides explanation to our results by linking digitalization and HC.

Originality/Value: Digitalization is quantified and examined in OCR. Moreover, this study reveals the importance of HC on the implementation of digitalization and the different effects of digitalization on each dimension of SCI.

Keywords: Digitalization, Supply chain integration, Human capital, Omni-channel retailing, Knowledge management

Paper type: Research Paper.

Introduction

In this era of rising consumer demands and technological advances, retailers have increasingly embraced an omni-channel retailing (OCR) strategy to provide consumers with seamless shopping experience across channels (Rodríguez-Torrico *et al*., 2017; Shen *et al*., 2018). Brick-and-mortar retailers such as Macy's, Nordstrom, and Walmart are expanding their online offerings and introducing new modes, such as in-store fulfillment of online orders. Online players such as Amazon and Zalando are opening their own brick-and-mortar stores (McKinsey, 2020). However, the channel alignment is a complex task because the challenges of selling through multiple channels will be made increasingly complex by innovation in shoppable formats, and will require greater holistic, end-to-end visibility of supply chains (Chopra, 2016; Rai *et al*., 2019). Only the joint efforts of every operation process in an entire supply chain enable the flow of information and goods to become as efficient, flexible, fast and cost effective (Cai *et al*., 2020). Therefore, supply chain integration (SCI) is key to a truly seamless OCR strategy.

In the context of OCR, the growing connectivity of devices, advances in artificial intelligence and automation all present the opportunity for more seamless supply chain integration (Huq, 2021). For example, retailers can use Big Data analytics to facilitate a streamlined and holistic view of customer behavior across all channels, or blockchain to foster mutual trust and long-term commitment among supply chain partners (Bain, 2020). Some big retailing brands, such as Amazon, views digital tools as core to its mission to get ever closer to their supply chain partners as well as consumers, spending a heavy proportion of their revenues on digital transformation. However, one study found that 84% of retailers acknowledge the need and importance for digital transformation, but on average have spent around £1.5m on transformation projects that have either failed or been cancelled (Aruba, 2020). The long-term investment challenge hinders the digital transformation of retailers with a mindset that demands immediate results. Therefore, exploring digitalization as the critical driver to the success of SCI of OC retailers could build confidence for retailers to accept the necessity of major digital investment.

In order to adapt to the changes brought by digitalization to the implementation of SCI of OC retailers, as the most difficult category of resource residing in firms, the importance of human capital (HC) cannot be ignored (Prajogo and Oke, 2016; Song and Song, 2021). In a recent survey, 31% of retail managers said that a challenge of digitalization was that "it requires new skills that people don't have in our organization" (Aruba, 2020: P4) .On the one hand, OC retailers need more multi-skilled talents who understand information technology and participate in supply chain design, so as to realize precision marketing according to customer demand, as well require employees to have affinity, communication and collaboration skills. On the other hand, the implementation of advanced tech-solutions requires retailers to have the right, digital-savvy leaders in place (Sima *et al*., 2020; Cai *et al*., 2020). Managers need to have a clear and consistent digital transformation strategy take on rapidly expanding and changing roles. Moreover, to remove employees' resistance to change, employers need to change their employees' attitude, to empower employees to accept the trends of digitalization (iScoop, 2020). Therefore, individual capabilities deserve more attention when retailers implement OCR strategy and digital transformation (Huq, 2021).

Although in practice, digitalization has brought huge changes to retailers' supply chain management (SCM), recent studies on digitalization has focused predominantly on the manufacturing and found that it leads to significant changes to manufacturing supply chains (e.g. Rakowski, 2015; Xu and Long, 2020), including the development of new products and services, operations, people and organizational management, business models, etc. Additionally, previous studies linking digitalization and human resource management

(HRM) claimed a more capable HC creates more digital innovations in manufacturing sector (e.g. Sima *et al.*, 2020; McKinsey, 2020). However, in the OC change of retail industry, such conclusions based on the manufacturing cannot be fully applicable to the retail industry because of their distinct industry characteristics. For example, compared with manufacturers, OC retailers directly target individual consumers and collaborate with many upstream distributors and suppliers (Adivar *et al.*, 2019; McKinsey, 2020). The complex and dynamic retail supply chain network and multi channels adds difficulty to realize SCI. Another example is that digital transformation in the manufacturing industry focuses on Research & Development and production (Roscoe *et al.*, 2019), while in the context of OCR is marketing, in order to increase consumer satisfaction, excavate consumer behavior, and improve operational efficiency (Cai *et al.*, 2020). Industry attributes also cause the significantly different requirements for human capabilities between manufacturing industry and the retail industry (Lee, 2017). Therefore, it is worth to further explore SCI and its potential antecedents in OCR.

The retail sector and especially its supply chains are facing drastic changes. Although the significance of SCI to the OCR strategy has been confirmed by the literature (Hübner *et al.*, 2016; Song *et al.*, 2019), as one of the industries most affected by digitalization, recent scholars appeal for the development of quantitative research to explore the impact of digitalization on the OCR supply chain and the role of "human" (Hagberg *et al.*, 2016; Cai *et al.*, 2020). Considering the considerable opportunity brought by digital transformation and the higher requirements for HC, this paper aims to explore how to promote SCI in the context of OCR. We ask the following two research questions, by empirically identifying the relationships between HC, digitalization and SCI:

RQ1. Does human capital cultivate digitalization of OC retailers?
RQ2. Does digitalization positively influence SCI in the context of OCR?

Knowledge is a fundamental strategic asset that contributes to the improvement and success of supply chains (Attia and Eldin, 2018). In this study, the view of knowledge management (KM) is applied for the following reasons. First, with the rapid change of customer requirements and the shortening lead time of products, organizations depend on the active participation of partners in the supply chain and sharing their needed knowledge to maintain competitive advantage (Attia and Eldin, 2018). Therefore, SCI can be considered as the strategic objective of KM. Next, since digital infrastructures help organizations to gather, structure, transfer or apply explicit knowledge through integrative applications and allows the exchange of tacit knowledge through interactive applications (Schniederjans *et al.*, 2019), a digitalization-based solution may help to achieve SCI. Last, "people" are the main drivers of KM, as KM relies on cognitive processes exercised by the human brain and involves socio-cultural interactions that digital technologies remain unable to capture (Rojas *et al.*, 2017). Fully extracting knowledge from the connections provided by digitalization depends on human intervention (Roscoe *et al.*, 2019).

Our study intends to contribute to the OCR supply chain research and practice by examining the relationships among HC, digitalization and SCI of OC retailers from the theoretical perspective of KM. An important contribution of this study is the confirmation of digitalization as the main driver of SCI in the context of OCR, bringing retailers confidence to approach the long-term investment challenge of digital transformation. It also provides evidence to support the application of KM perspective in the novel era, as KM perspective provides a new insight to the conceptual model and the explanation of results. Additionally, we also uncovered some interesting and surprising results, compared with prior studies. For instance, we

reveal that digitalization contributes most to internal integration, suggesting retailers should first pay attention to the development of related digital technologies for internal integration to get a faster return. We also suggest that OC retailers should exert more effort in developing employees' capital (compared to manager's) to facilitate the application of digitalization, since our results expose that employees' capital have a greater impact on digitalization.

The remainder of this study is organized as follows. Section 2 reviews and categorizes related publications (e.g., journal articles, theses, and internet reports). Section 3 discusses the conceptual models of HC, digitalization, and SCI and puts forth various hypotheses. Section 4 describes the analysis process and the results of this study's empirical research. Section 5 presents a discussion on this study's empirical results as well as its theoretical and managerial implications. Section 6 considers the limitations as well as possible future directions.

Literature Review

Digitalization

Digitalization is defined as the process of transforming an organization from a traditional to a new way of working and thinking by using digital, social, mobile, and emerging technologies (Burnson, 2018). Several existing studies have qualitatively confirmed the positive role of digitalization in fostering a stronger competitive edge. For example, Rakowski (2015) addressed how technology drives a new wave of productivity through the digitalization of key organizational and financial processes. Furthermore, for the framework and measurement of digitalization, a few of literature offer contributions. Schniederjans *et al.* (2019) linked KM with digitalization and put forth three pillars when implementing digitalization: technology, process, and people. Büyüközkan and Göçer (2018) presented a comprehensive framework in which digitalization was divided into five parts, namely digital strategy, digital organization/culture, digital product/service, digital operation, and digital customer experience.

A few recent studies have stated that digitalization has also brought benefits to OC retailers such as the redesign of cross-channel inventory policies and customer information databases, and the establishment of consistency in customer service (Adivar *et al.*, 2019, Li *et al.*, 2019). Figure 1 shows the main application of digitalization in OCR supply chain. Although interest in digitalization has been stimulated worldwide, there is still lack of quantitative research regarding the role of digitalization in OCR supply chain management.

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Take in Figure 1

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Human Capital in Digitalization

Management literature described HC as the sum of managers' and employees' skill, attitude, and interrelationship (Jin *et al.*, 2010; Flothmann *et al.*, 2018). Managers are responsible for decision making and play a strategic role in the organization (Porter, 1980). Their specialized and analytical abilities within his or her specialty are important for making the right decisions, as well the ability to work effectively with people is essential for developing group collaboration (Benson *et al.*, 1991). Employees on the other hand

are responsible for the implementation of decisions and play a practical role in the organization. Employees' business capability, problem-solving skills, operations knowledge, and creativity provide firms with distinct competencies (Levy and Murnane, 2004; Youndt *et al.*, 1996). Moreover, when employees have strong interpersonal relationships with coworkers and external partners, trust among them enables employees to bemore willing to share knowledge with coworkers and external partners.

Previous researchers have reached a consensus that HC is the key resource needed to support the efficient use of digitalization. For example, Kosmol *et al*. (2019) considered people's capabilities as a key factor in determining the success of digitalization because people and digital technology go hand-in-hand. The main reason explained by scholars, such as Kornelakis and Petrakaki (2020), is that if firms are to catch up in the digital transformation race, it needs to overcome employees' skill gaps and scarce leadership capabilities (Sima *et al*., 2020; Zhou *et al*., 2020).

Despite several contributions about the relationships between HC and digitalization, there are still research gap that should be filled. As a specific industry in which the level of digitalization is high, OCR also has already generated higher requirements for HC (Kosmol *et al*., 2019), as they need to participate in digital transformation in different channel scenarios that have distinct characteristics. However, few studies quantitatively addressed the effects of HC on digitalization from the context of OCR. Therefore, we measure HC from the perspectives of managers and employees separately to consider the roles of the different actors on OC retailers' digitalization.

Digitalization in Supply Chain Integration

As current competition is among supply chains and not between individual organizations, SCI is the key to gain competitive advantages (Song *et al*., 2019). OCR is characterized by operations with continuous information exchange, joint operations, and supply chain network across channels that enable a conflation of the order fulfillment process (Hübner *et al*., 2016). Therefore, the realization of OCR requires not only the internal integration of retailers, but also the joint efforts with other entities within the whole supply chain (Cai *et al.*, 2020). First, internal integration facilitates collaboration within all the channel departments by breaking down functional barriers, including continuous information exchange, joint operations, a conflation of the order fulfillment process, integrated inventories and customer management across channels (Chen *et al*., 2018). Next, to deliver fast, impeccable, flexible and efficient omnichannel service retailers should maintain a stable and deep relationship with their suppliers. Supplier integration consists of a strategic collaboration between retailers and suppliers in all production activities (e.g. joint inventory decision) (Delic *et al*., 2019; Song and Song, 2021). Third, retailers manage their pull-based supply chain, and they need to create and deliver new value to customers (Vishal *et al.*, 2019). Customer integration refers to the collection of individual customer data, learning about customer needs and behavior contributes to more wise operation decision-making and competitiveness improvement (Rodríguez-Torrico *et al*., 2017; Feyissa *et al*., 2019).

Prior studies (Feng and Shanthikumar, 2018; Cole *et al*., 2019, Yu *et al*., 2020) broadly linked digitalization and main issues in supply chain management (e.g. information sharing, supply chain cooperation, demand planning). For example, Feng and Shanthikumar (2018) found that manufacturing firms are now able to obtain individualized customer data to personalize the sales process, product design and service through smart devices. Only few scholars have discussed digitalization and SCI, developing propositions based on exploratory studies. For example, Shi *et al*. (2020) and Feyissa *et al*. (2019) found that digitalization is able to coordinate complex activities in a supply chain by facilitating improvement in a

firm's collaborative and communication capabilities as well as their level of SCI. Based on the resource-based view and organizational capability theory, Yu *et al*. (2020) showed supplier and customer IT systems significantly promote supplier and customer system and process integration. However, existing studies mainly focus on manufacturing industry, the effect of digitalization on SCI in OCR is still unexplored, although the importance of SCI in the implementation of OCR strategy has been confirmed (Ishfaq *et al*., 2016; Song *et al*., 2019).

Knowledge Management

Knowledge management (KM) is defined as creating, storing/retrieving, transferring, and applying knowledge inter- and intra- organizations (Alavi and Leidner, 2018). KM is considered vital to implementation of supply chain practice in a business environment characterized by rapid changes, technological advancements, changing customer needs and higher competition (Schoenherr *et al*., 2014). The main reason is that KM among supply chain members would lead to more effective and efficient supply chain collaborations as well as long-term survival and competitive advantage (Wilkesmann and Wilkesmann, 2018). Therefore, considering SCI represents the extent to which a company can collaborate with partners and manage its processes to achieve effective and efficient flows of products and services to the final customer (Huo, 2012), it is reasonable to explore how to better promote SCI from the KM perspective.

Apart from the broad application of KM in SCM field, KM perspective can also provide the theoretical lens to link HC and digital transformation (Büyüközkan and Göçer, 2018; Yahya and Goh, 2002). Research claimed that we are living in an era in which data is generated in huge volume with high velocity and variety (Alavi and Leidner, 2018; Attia and Eldin, 2018). Digital technologies are reshaping business operations in retail industry (Chopra, 2016; Bain, 2020; Cai and Lo, 2020), and assists routines that support KM practices within industrial applications (Wilkesmann and Wilkesmann, 2018). To fuse and make full use of online and offline, retailers need to master new skills and obtain valuable knowledge about "going digital to enhance their services" and how to deliver high-quality information and convey value (Hagberg *et al.*, 2016; Wang and Xu, 2018). Thus, human factors couldn't be ignored, as previous literature claimed that humans are the central bearers of knowledge. Human factor can be understood as support tools or practices for innovative initiatives to be implemented (Yahya and Goh, 2002). Based on the literature review, KM perspective could offer the theoretical foundation for our study to explore the relationships among HC, digitalization and SCI in the context of OCR.

Hypotheses Development

SCI requires retailers not only to manage internal knowledge, but also to absorb and acquire knowledge from external supply chain partners (Shou *et al*., 2018; Schniederjans *et al*., 2019). Based on the KM perspective, this study aims to identify the relationship between HC, digitalization, and SCI under the context of OCR. Among others, HC is considered as the main facilitator of KM, digitalization provides a creative solution of KM, whereas SCI is the strategic objective of KM. This study's conceptual model is illustrated in Figure 2 and the rationale for the hypothesized model is explained below. Previous literature on SCI showed that the influence of control variables (e.g. firm age, firm size) on the level of integration is relatively weak (Oh *et al*., 2012; Yu *et al*., 2017). Moreover, there was no theoretical evidence to support the impact of firm characteristics on the degree of digitalization. Therefore, considering that adding control variables may not provide sufficient theoretical contribution in this study, control variables were not considered in the conceptual model.

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Effects of HC on Digitalization

As KM is based on the ability of a firm's members to add value to business processes through the creation, sharing, codification and integration of explicit and tacit knowledge, managers play an essential role (Büyüközkan and Göçer, 2018). Managers with digital knowledge can think up an array of creative solutions to address how to utilize digital technology to produce knowledge in a short period of time, how to convey knowledge to the growing multitude of customers in digital spaces (Batran *et al.*, 2017). Moreover, leaders with good human skills can motivate employees to grow their careers and adapt to new trends (i-SCOOP, 2020), supporting the sharing of both explicit and implicit knowledge within the organization (Chen *et al.*, 2018). Previous literature has widely recognized that supporting top management is a critical enabler for strategic digitalization initiatives (Kosmol *et al.*, 2019) and for digital technology use in organizations, because people engaged in key roles on digitalization initiatives ensure the collaboration between units (McKinsey, 2018), Therefore, we propose the following hypothesis:

H1. Managers' capital is positively related to digitalization when retailers implement an OC strategy.

To effectively cope with the new challenges of the digital workplace, employees must develop specific abilities, skills, knowledge, and attitudes (Park and Kim, 2018). First, retailers that have experts with rich digitalization knowledge realize the implementation of advanced tech solutions (Wang and Xu, 2018). Second, employees provide services directly to customers, so employee attitudes toward work affect their timely perception of consumer demand preferences and play an important role in improving the OCR digital experience (Hagberg *et al.*, 2016). Third, high-quality employees are more capable of knowledge identification and absorption, team cooperation and communication within organization, leading them to accept the trends of digitalization (Park and Kim, 2018). Therefore, we propose the following hypothesis:

H2. Employees' capital is positively related to digitalization when retailers implement an OC strategy.

Effects of Digitalization on SCI

Being aware of a company's knowledge management and using digital technology to strengthen it, can facilitate the internal integration (Gao *et al.*, 2020; Wilkesmann and Wilkesmann, 2018). First, advanced information technologies can be used to systematize, enhance, and expedite large-scale internal explicit knowledge storing and transferring, enabling employees to more easily work and collaborate across channels (Attia and Eldin, 2018). Second, retailers can create a network of cross-functional teams with end-to-end accountability that features fewer barriers, improving knowledge transferring (Schniederjans *et al.*, 2019). Third, digital technologies like AR and VR, can improve the seamless experience among channels, reflecting the application of digital knowledge in OCR (Delic *et al.*, 2019). Then, Therefore, we propose the following hypothesis:

H3. Digitalization is positively related to the level of internal integration when retailers implement an OC strategy.

In OCR, the rapid change in customer demand and the shortening of product delivery time makes it difficult for an organization to maintain its competitive advantage. KM posits that symmetrical knowledge

exchange between firms and suppliers, which can be achieved through digitalization, is crucial to the success of an OC strategy (Attia and Eldin, 2018). First, digitalization enables not only communication between machines but also sharing the knowledge throughout the supply chain network to keep downstream and upstream supply chain partners informed of various processes (Chen *et al.*, 2018; Gottge *et al.*, 2020). Second, digitalization ensures the timeliness and effectiveness of joint decision-making and knowledge sharing between retailers and suppliers especially during emergencies (Hübner *et al.*, 2016). Third, digital technology can promote transactional authenticity and safety, fostering trust in knowledge sharing and maintaining long-term relationships on both sides (Wiengarten *et al.*, 2019). Therefore, we propose the following hypothesis:

H4. Digitalization is positively related to the level of supplier integration when retailers implement an OC strategy.

In the context of OCR, the customer experience remains a driver of retail innovation (Rai *et al.*, 2019). The KM perspective considers customer knowledge to be an essential issue, whose goal is to continuously improve the service experience through customer integration (Wang and Xu, 2018). The use of new knowledge and technologies in the development process to significantly improve customers' purchase, delivery, and consumption patterns for products and services (Bell *et al.*, 2017). Moreover, technology can help achieve quick response to orders and precise demand prediction by using data mining techniques to collect relevant information about the knowledge and skills needed in fast-changing retail marketing (Vishal *et al.*, 2019). Retailers can convey knowledge to the growing multitude of customers in digital spaces as well acquire feedback based on customer knowledge, enabling them to improve product design and operational process (Aruba, 2020). Therefore, we propose the following hypothesis:

H5. Digitalization is positively related to the level of customer integration when retailers implement an OC strategy.

Research Methodology

Sampling and Data Collection

As the largest developing country and e-commerce market, the Chinese mainland presents tremendous value and potential to the retail sector. In 2019, the overall revenue of Chinese retail reached 6T USD, and comprised of 57.8% of China's economic growth. Moreover, online retail revenue totaled more than 1.46T USD (Economic Daily, 2020). Moreover, both pure e-commerce and traditional retailers began establishing more diversified channels through the use of digital technologies to stimulate demand and improve their marketing advantage in China's market (MOFCOM, 2019). Therefore, analyzing a sample made up of Chinese retailers is of great significance in studying OCR.

The unit of the analysis is a retailer who is implementing OCR strategy. The sampling pool was chosen from the China General Chamber of Commerce (CGCC), which is a national trade organization registered by the Ministry of Civil Affairs of the People's Republic of China in 1994 (URL: https://www-cgcc-org-cn.vpn2.gxun.edu.cn/). Initially, after communicating with CGCC about the research objectives and the request to participate in the study, CGCC provided a list of retailers who were registered members and clearly expressed their active involvement and strong interest in OCR strategy. The final sampling pool comprised 874 retailers. The research questions include not only high-level constructs, but also the functional issues in

operational-level. To receive valid perceptional responses, a manager (such as CEOs, directors / managing directors, and general managers) or senior staff who have worked for many years and undertake daily management tasks, such as team leader, could be the valid key informant to interpret the phenomenon under investigation (Krause *et al.*, 2018). Moreover, considering the consuming of time and cost, the single key-respondent survey is applied in this study (Montabon *et al.*, 2018).

Before launching the questionnaire, we carried out the pre-test with interviews of three managers and three senior employees from OC retailers, and the necessary modifications were conducted based on their feedbacks to ensure the acceptability and understandability. Then, we conducted the survey by e-questionnaires within one month using a two-wave procedure. Two weeks after the initial e-mailing, a reminder e-mail was sent to each retailer. Finally, 202 completed questionnaires were returned. After eliminating 14 responses with a substantial number of missing values and inconsistencies, we obtained 188 usable responses. The response rate of 21.5% is considered reasonable because the survey was unsolicited and involved the participation of senior management. Table 1 provides the profile of our sample retailers, showing that the sample represents a variety of industries and firm sizes. Most of our respondents were middle or top managers and had been in their positions for many years. Thus, they should be knowledgeable about their companies' activities of digital transformation and SCM.

In the questionnaire, every question was mandatory and required an answer, encouraging them to provide accurate data. With regard to non-response bias, we compared the first (62 in total) and last thirds (43 in total) of the responses on their demographic characteristics of age, annual revenue, ownership and sector type, using two approaches. The *t*-test results reveal that there is no significant statistical difference ($p>0.05$) among the category means for the demographic characteristics. Moreover, the results of the chi-square test indicate that there is no significant difference between early and last thirds responses on all four demographic categories (i.e. age, annual revenue, ownership and sector type) based on the results of $p>0.05$. In summary, we conclude that non-response bias is not a major concern in this study.

Since there was only one respondent for each questionnaire, common method bias (CMB) might have been a problem. We applied a two-pronged approach to test the impact of CMB. First, six factors with eigenvalues higher than 1.0 were extracted based on exploratory factor analysis, explaining 77.56 percent of the total variance. The results showed that the constructs are conceptually and practically correlated. Second, the single-factor model was examined through confirmatory factor analysis, and the fit indices (χ^2/df=9.042, RMSEA=0.183, NFI=0.561, CFI=0.582) presented an unaccepted level. We concluded that no single factor emerged from the factor analysis and that no general factor explained the majority of the variance. Therefore, CMB was not a serious problem in this study.

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Measurement of Constructs

In this study, a comprehensive review of the studies across the fields of HRM, SCM, OCR, and digitalization in Internet reports (e.g. McKinsey, Bain) and academic researches was conducted to identify potential measures for the conceptual constructs. Consequently, 35 measured items were adopted, and the supported references are listed in Appendix.

First, we searched the previous literature to develop valid measures for our constructs. Specifically, the measurements of managers' capital and employees' capital involve three dimensions: skills, attitudes, and interpersonal relationships (e.g. Song *et al.*, 2020). Digitalization was measured through strategy, culture, operations, product/services, and customer experience (e.g. Kosmol *et al.*, 2019; Büyüközkan and Göçer, 2018), and SCI was measured via internal, supplier, and customer integrations (e.g. Macarena *et al.*, 2018). Although most of the measurement items come from existing literature, we have revised them based on the distinct characteristics of OCR supply chain. For example, HC emphasizes cross-channel departmental collaboration capabilities, and digitalization includes providing digital consumer experience. Internal integration mainly emphasizes the integration of information, process and organization across channels. Supplier integration mainly refers to the sharing of operational information (e.g. inventory information) and joint operational decision-making with suppliers. Customer integration includes not only providing customers with cross-channel products, services, and order visualization, but also receiving feedback from customers. We used a five-point Likert scale to capture respondents' perception of the levels of HC, digitalization and SCI. Each item was assessed by the strength of respondent's agreement, with "1" indicating "strongly disagree" and "5" indicating "strongly agree".

Reliability and Validity

Exploratory factor analysis was conducted to ensure the unidimensionality of the scales. A principal component factor analysis with varimax rotation was used to detect the underlying dimensions. All items had strong loadings (greater than 0.5) on the specific factor that they were intended to measure. Cronbach's alpha (α) was computed for each construct to check its internal consistency. Table 2 demonstrates that all α values were above 0.8 and that all composite reliability values were greater than 0.8, thus confirming the reliability of the constructs.

Confirmatory factor analysis was conducted to assess both convergent and divergent validity. In the model used to check convergent validity, each item was linked to its corresponding construct and the covariance among constructs was freely estimated. The model fit indices were χ^2 (545) = 1082.370, χ^2/df = 1.986, RMSEA = 0.071, CFI = 0.909, GFI = 0.858, AGFI = 0.887, NFI = 0.880, and TLI = 0.931, indicating that the model fit was acceptable. Furthermore, all factor loadings were greater than the 0.5 cutoff and all *t*-values were greater than 2.0. Therefore, convergent validity was ensured. As for discriminant validity, all inter-construct correlations were lower than the square root of the average variance (AVE) extracted for each factor, thus discriminant validity was also ensured (see Table 2).

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Results

Structural equation modeling (SEM) with the maximum likelihood estimation method and LISREL 8.70 software were used to estimate the relationships among the constructs. To minimize multicollinearity, the independent variables and the moderators were mean-centered (Marodin *et al.* 2017). Moreover, the variance inflation factors were computed, and the value of 1.83 reveals that the data set is suitable for regression analysis. The model fit indices were χ^2 (550) = 1043.353, χ^2/df = 1.897, RMSEA = 0.059, CFI = 0.896, GFI = 0.903, AGFI = 0.825, NFI = 0.891, TLI = 0.929, all of which exceed the threshold values

suggested by Hu and Bentler (1999). Figure 3 shows the SEM results with the standardized coefficients for the significant paths. Among the 5 proposed hypotheses, all are supported at the 0.001 significance level. The results show that the effects of managers' capital and employees' capital are significant, supporting H1 and H2. The results also indicate that digitalization has a positive effect on internal integration, supporting H3, as well a positive impact of digitalization on integration with suppliers and customers, supporting H4 and H5.

Furthermore, we statistically test the difference of the effects of managers' capital and employees' capital on digitalization, as well as the effects of digitalization on three dimensions of SCI. The result ($\Delta\chi^2$= 5.409, p<0.001) suggests that employees' capital has a greater effect on retailer digitalization (H2, β = 0.526) than managers' capital (H1, β = 0.360). Similarly, digitalization has the greatest impact on internal integration (H3, β=0.872) and a minimal impact on supplier integration (H4, β = 0.419) as a result of $\Delta\chi^2$ (internal integration & customer integration) = 2.184 (p<0.001) and $\Delta\chi^2$ (internal integration & supplier integration) = 41.142 (p<0.001).

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Discussion and Implications

Discussion of the Results

Our findings provide substantial empirical support for the positive relationships among HC, digitalization and SCI in the context of OCR. The study's first objective is to examine the effects of HC's two dimensions on the digitalization of OC retailers. Our findings show that both managers' capital and employees' capital have positive effect for OC retailers on digitalization, which is consistent with the views of HRM and SCM studies such as Frederico *et al.* (2019). However, different from the explanation of this phenomenon in existing papers, the KM perspective provides a useful theoretical lens to explain the findings in this paper. Critical portion of the knowledge and skills required for digital innovation resides with and is used by individuals, while SCI can be improved by digitalization due to the opportunities surrounding digitalization have made it possible for supply chains to access, store and process a large amount of knowledge both from within the retailer and externally. Further, our findings add to extant literature by finding that employees play a more critical role in the success of digital transformation. Considering the retail industry in China is still labor-intensive, creative and knowledgeable employees are more likely to develop new and innovative ideas (Hagberg *et al.*, 2016).

The study's second objective is to investigate how digitalization promote retailers' SCI. Consistent with the views described in the previous studies, our findings also confirm the positive effect of digitalization on SCI. Today, knowledge is an important strategic asset. SCI relies on knowledge sharing and transferring within the whole supply chain (Schniederjans *et al.*, 2019). Digitalization provides the opportunities to effectively implement KM inter-organizations. Thus, retailers can reap the benefits of SCI with digital transformation into SCM. Our findings also indicate that digitalization has the greatest effect on internal integration. This is an interesting finding given that, only few studies claimed organizations must first

develop the integration intra-organizations through system, data, and process integration before they can engage in meaningful external integration (Chen *et al.* 2018; Zhu *et al.* 2018). Based on the KM perspective, data integration and knowledge integration among internal departments facilitate firms to combine prior knowledge from the repository with their newly absorbed knowledge, thereby expediting the value of the knowledge acquired in the external supply chain (Shen *et al.*, 2019; Zhang *et al.*, 2018). Further, as for the relatively weaker impact on supplier integration, can be explained by the characteristics of the respondents. As shown in Table 1, about 65% retailers reported that their annual revenue is over 200 million of RMB. Revenue represents market position and power to a certain extent. Therefore, in the retailer-leading supply chain, retailers can rely on their own supply chain power to achieve supplier integration, which weakens the role of digitalization.

Theoretical Implications

Our study makes significant contributions to the extant literature. On the one hand, to the best of our knowledge, this study is the first to investigate the relationships among HC, digitalization and SCI within the context of OCR. Although studies such as Büyüközkan and Göçer (2018) suggested a link between digitalization and SCM and the important role of human in supporting the successful digital transformation, mostly focusing on manufacturing industries, it was unknown whether these relationships still exist in the context of OCR. Due to the distinct characteristics between manufacturing and retailing in terms of supply chain structure, the path of digitalization, and the requirements of HC, our study contributes to the extant literature in that it validates the positive effects of digitalization and HC in promoting SCI in the context of OCR. Thus, the findings pertaining to the relationships among HC, digitalization, and SCI extends prior research on digitalization and SCI in the context of OCR.

On the other hand, this study clarifies the main driving factors of SCI and explore the differences of driving effects based on KM, although SCI as the key to achieving successful OCR is generally considered to be certain (Murfield *et al.*, 2017; Song *et al.*, 2019). The theoretical lens of KM in this paper informs the development of conceptual model, where HC is the main facilitator, digitalization provides a creative solution, and SCI is the strategic objective, and adds explanatory power to our results (Zorzini *et al.*, 2015). For example, our results show that HC, especially employees' capital is the main facilitator of digitalization as expedites the extraction of knowledge. Furthermore, we are able to present a more nuanced understanding of the effect of digitalization on SCI. We reveal that digitalization as a creative solution which helps organizations to gather, structure, produce, convey, and apply knowledge have varied impact on the three dimensions of SCI - internal integration, supplier integration, and customer integration. Namely, digitalization has the biggest impact on internal integration whilst there is a relatively weaker impact on supplier integration, which seems to be counterintuitive.

Managerial Implications

The managerial implications of this paper are three-fold. First, our results motivate retailers to focus on the cultivation of HC, especially the employee level. Pursuing high level of HC with strong emphasis on the development activities for employees would likely improve their chances of reaping better benefits in digitalization, as the implementation of advanced tech solutions requires retailers to have the digital talents to manage the digitalization strategy. Second, the positive effect of digitalization on three dimensions of SCI has been confirmed. Thus, retailers should accept the necessity of major investment in digitalization to possess the higher level of SCI and maintain competitive advantages. Third, we also suggest retailers to pay more attention on internal integration. Retailers should adopt a series of internal digital practices (e.g.

internal digital culture, internal digital operations, giving day-to-day tools a digital upgrade). Starting from internal digitalization, advanced technologies enable retailers to digitize and integrate resources and operations from physical and online retail channels.

Conclusions, Limitations, and Future Research

This study identifies the relationships between HC, digitalization, and SCI in the context of OCR based on a KM perspective. Some findings are consistent with theoretical expectations and the findings of previous studies in that both managers' capital and employees' capital are positively related to the level of a firm's digitalization and that digitalization is positively related to the level of SCI. Moreover, we found that employees' capital has a greater impact on digitalization than managers' capital, while digitalization has a stronger driving effect on internal integration and customer integration.

Although this study makes a significant contribution to the literature and practice, there are a few limitations that provide avenues for further research. First, the digitalization of industry is changing the roles and responsibilities of personnel, requiring transformation of Human Resource Management (HRM) functionalities (Zhou *et al*., 2020). Therefore, it might be an opportunity to examine the effect of HRM on SCM in the context of OCR, whereas this issue has been neglected in this study. Second, considering the issue of HC is about the HR level while digital transformation and SCM is about strategic level, professional respondents from different departments participate in the questionnaire in a company may provide more reliable information. Third, to obtain the most comprehensive information from the most appropriate person, multiple respondents from different functions and hierarchies should be required to complete certain sections of the questionnaire. Future studies could perform the multi-respondent survey to further improve the accuracy of the information. Finally, in this paper, we developed the conceptual model without considering of any control variables. Future studies could investigate and compare the effect of potential control variables (e.g. firm age, firm size, firm ownership) on digitalization and SCI.

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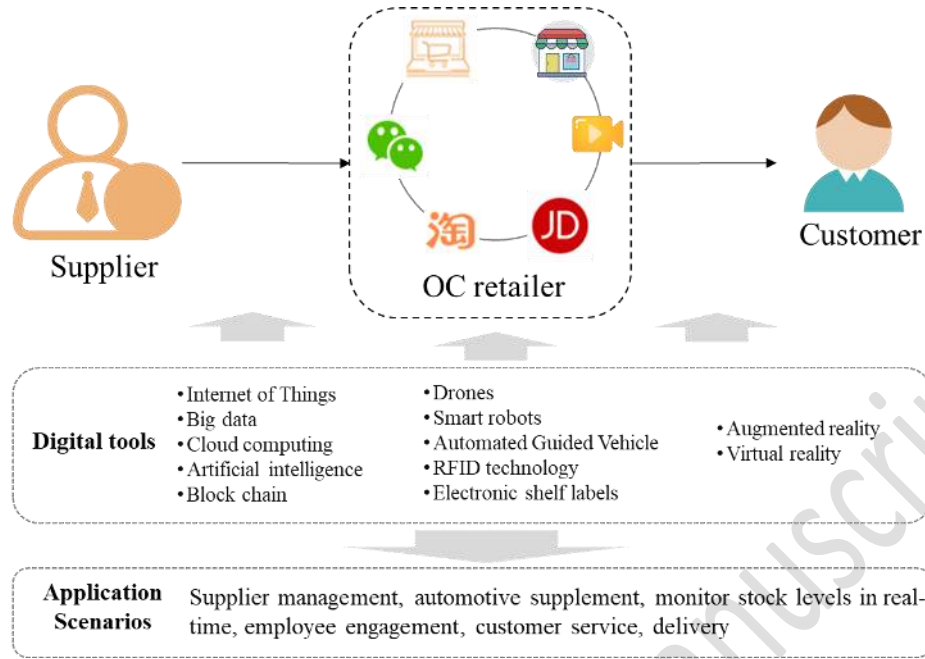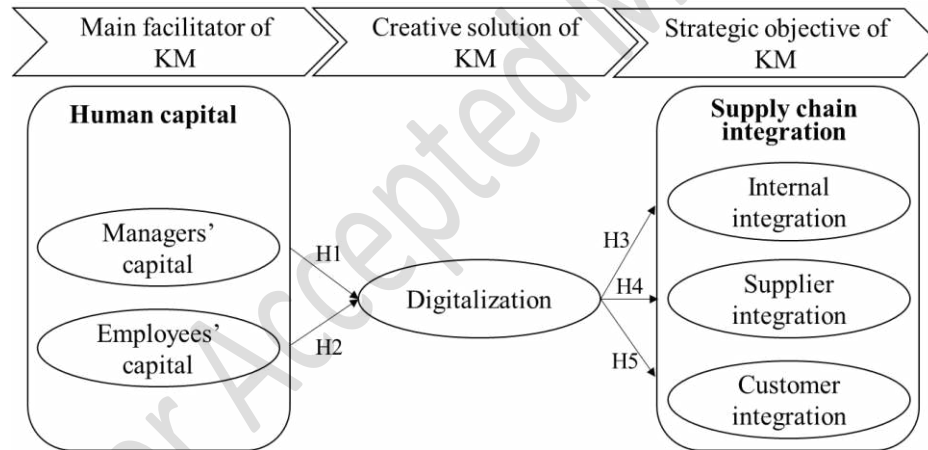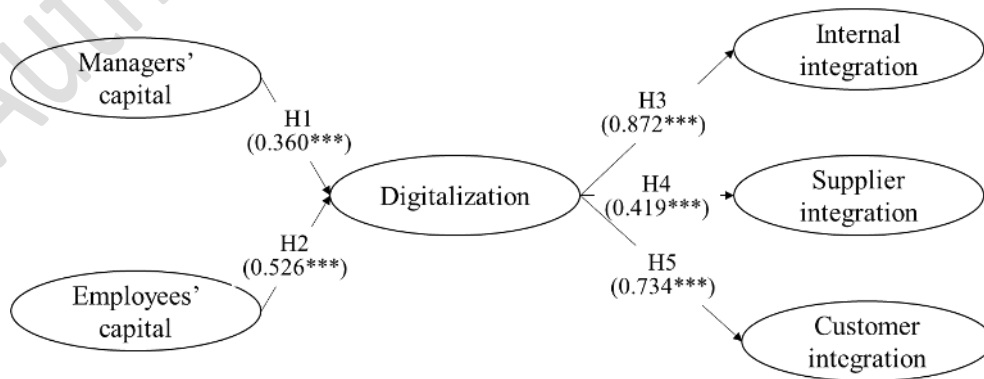
Figure 1. The Digital Application in OCR

Figure 2. Conceptual Model

Note: Solid lines indicate significant relationships. *p<0.10; **p<0.05; ***p<0.01

Figure 3. The Estimated Results of the SEM Model

Table 1. Profile of the Respondents and Their Firms

	Total (%) (n = 188)
Respondent's position (%)	
Top manager	8.0
Middle manager	61.7
Senior staff	30.3
Age of the firm (in number of years)	
Less than 5	15.5
5-10	27.5
11-15	16.0
16-20	12.8
More than 20	28.2
Annual revenue (in millions of RMB)	
Less than 50	13.3
50-100	12.2
100-200	10.1
200-2000	35.1
More than 2000	29.3
Ownership of the firm (%)	
State-owned	50.5
Local private	37.2
Foreign	5.3
Joint venture	6.9
Sector type (multiple choice) (%)	
Manufacturing	31.9
Commodity circulation	21.8
E-commerce	9.6
others	42.0
The proportion of staff aged 25-40 (%)	
<20	3.2
21-40	17.0
41-60	41.5
61-80	22.9
>80	15.4
The proportion of staff with a bachelor's degree or higher (%)	
<20	5.3
21-40	19.7
41-60	13.3
61-80	22.9
>80	38.8

Table 2. Reliability, Validity, Mean, Standard Deviation, and Correlation

	1	2	3	4	5	6
1. Managers' capital	**0.777**					
2. Employees' capital	0.217	**0.766**				
3. Digitalization	0.229	0.159	**0.799**			
4. Internal integration	0.361	0.379	0.188	**0.801**		
5. Supplier integration	0.393	0.280	0.352	0.290	**0.788**	
6. Customer integration	0.353	0.278	0.204	0.300	0.210	**0.796**
Mean	4.000	3.836	3.866	3.629	3.568	3.797
SD	0.850	0.762	0.815	0.892	0.837	0.801
Cronbach's α	0.841	0.886	0.862	0.872	0.837	0.895
Composite reliability	0.898	0.893	0.895	0.915	0.906	0.911

Note: Numbers on the diagonal are the square roots of the AVE values. *p <0.05; **p <0.01; ***p <0.001

Appendix. Construct Measurement

Managers' capital (Song *et al.*, 2020; Shou *et al.*, 2018; Prajogo and Oke, 2016)

In the firm, managers…

    make sure the workforce has the skills for the future

    have professional ability and digital-savvy skill

    engage actively in a digital transformation

    promote a culture of innovation and change

    ensure collaboration between internal units on digital transformation initiatives

    have good relationship with their supply chain partners

Employees' capital (Song *et al.*, 2020; Flothmann *et al.*, 2018; Wilkesmann and Wilkesmann, 2018)

In the firm, employees…

    have high-level skills in their respective jobs

    have useful experiences about their own routine duty

    deeply involved in developing digital initiatives than during past change efforts

    are willing to contribute with ideas for organizations

    are willing to cooperate with other departments' staff

    have good relationship with their supply chain partners

Digitalization (Schniederjans *et al.*, 2019; Kosmol *et al.*, 2019; Büyüközkan and Göçer, 2018)

To accomplish digitalization, firms…

    have clear digital goals and specific investment for digital strategy in annual budget

    establish at least one new way of working, such as continuous learning or open work environments

    standard operating processes are modified to include new digital technologies

    provide digital products/ service to meet their customers' personalized needs

    implement digital self-serve technologies for employees, business partners, customers to use

Internal integration (Feyissa *et al.*, 2019; Macarena *et al.*, 2018)

As OC retailers, firms…

    have integrated information system among different departments/channels

    share real-time operational data among departments/channels

    develop mechanisms for internal information sharing and confidentiality

    implement process integration, such as integrated warehousing and distribution

    create network of cross-functional teams to corporate decision-making mechanisms

    have efficient collaboration among departments/channels

Supplier integration (Wiengarten *et al.*, 2019; Delic *et al.*, 2019; Rajesh and Margaret, 2019)

As OC retailers, firms…

    share real-time operational information with their suppliers

    share performance matric with their suppliers

    have common information systems or a unified data interface with their suppliers

    design business processes with their suppliers jointly

    maintain long-term relationship with their suppliers

    establish a stable cooperative relationship with their suppliers

Customer integration (Wiengarten *et al.*, 2019; Chen *et al.*, 2018; Macarena *et al.*, 2018)

As OC retailers, firms…

    have customer-oriented information platforms to display products

    provide service of order visualization to customers

    have agile response to customers' orders

    provide convenient feedback ways to customers

    make demand forecast with customers jointly

    have a perfect customer relationship management system